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**SYSTEM AND METHOD FOR
ENSURING AND MANAGING
SITUATION AWARENESS**

Field of the Invention

The present invention relates generally to monitoring of data streams, and more particularly, relates to providing situation awareness by monitoring incoming data streams using a rule base. The incoming data streams can be sent
5 by hunter and gatherer agents or can be incoming message traffic .

Background of the Invention

In government and commercial environments, human activity is directed at understanding events in the real world and solving problems based on that understanding. This process is called Situation Awareness.

10 Rapid advances in computer technologies such as remote sensing, networking and data mining have in many cases overwhelmed organizational and visualization tools used to interpret and respond to the information. As autonomous intelligent agents and subscription-based "push" technology becomes commonplace, this flood of information will increase to tidal wave proportions.

15 The traditional response to these types of problems has been to build an individualized user environment tuned carefully to the needs of the specific problem to be solved. Each type of data processed or produced by the system has a customized user interface dedicated to exploiting it.

20 While this approach can be effective, experience has shown that it is also often expensive and high-risk to build such systems. A major reason is that there is little opportunity for code reuse; the system must be built from the ground up. After becoming operational, these systems tend to be hard to adapt to changes in an organization's workflow process. These factors led us to seek "horizontal" system architectures and end user environments; as the problem of data overload

becomes part of everyone's experience, the need for such solutions becomes urgent.

Intelligent systems have been developed which are focused on the needs of situation awareness users. These systems shared a common internal system architecture that significantly lowered system development cost and risk. The flexibility of the architecture was demonstrated when it solved a wide variety of user problems including terrorist activity analysis, low intensity conflict monitoring, military intelligence, and strategic threat assessment. However, the goal of a generic user environment remained unrealized throughout this period.

Some generic, reusable user tools could be developed, but most had to be closely linked to the problem being solved.

Summary of the Invention

It is, therefore, an object of the present invention to provide a method and apparatus for monitoring and sorting incoming data streams using a rule base.

It is another object of the present invention to provide incoming data stream which is sent by hunter agents and gatherer agents to a presence.

It is another object of the present invention to provide a rule base which can sort the incoming data streams and provide a display of an event stream on a time line.

These and other objects of the present invention are achieved by a method and apparatus in which one or more data streams are sent to a computer and the data streams are sorted using a rule base into streams representative of events. The incoming data streams can be sent by hunter agents which search for specified types of data and forward the data to the computer. The incoming data stream can also be sent by a gatherer agent. The incoming data stream can also be incoming message traffic such as e-mail and other types of message traffic data. The incoming message traffic data is then sorted into event streams and can be displayed as event streams on a time line. Actions can be taken based upon

specified events. Thus, events from disjointed sources can be sorted and displayed in a unified manner in which a user can readily and quickly know which events have occurred for a particular issue, such as a forest fire, hospital patient, etc.

5 The foregoing objects of the present invention are also achieved by a method for monitoring an incoming data stream for specified events. At least one data stream is received at a computer, the data stream including data representative of events. Rules are applied to the data stream for sorting data representative of events and for taking an action based on a specified event.

10 The foregoing objects of the present invention are also achieved by an article including at least one sequence of machine executable instructions. A medium bears the executable instructions in machine readable form, wherein execution of the instructions by one or more processors causes the one or more processors to receive at least one data stream at a computer, the data stream
15 including data representative of events. The processors apply rules to the data stream for sorting data representative of events and for taking an action based on a specified event.

 The foregoing objects of the present invention are also achieved by a computer architecture for monitoring an incoming data stream for specified
20 events. The computer architecture includes receiving means for receiving at least one data stream at a computer, the data stream including data representative of events. The computer architecture also includes applying means for applying rules to the data stream for sorting data representative of events and for taking an action based on a specified event.

25 The foregoing objects of the present invention are also achieved by a computer system including a processor and a memory coupled to the processor, the memory having stored therein sequences of instructions, which, when executed by the processor, causes the processor to perform the following steps. At least one data stream is received at a computer, the data stream including data

representative of events. Rules are applied to the data stream for sorting data representative of events and for taking an action based on a specified event.

Still other objects and advantages of the present invention will become readily apparent to those skilled in the art from following detailed description, wherein the preferred embodiments of the invention are shown and described, simply by way of illustration of the best mode contemplated of carrying out the invention. As will be realized, the invention is capable of other and different embodiments, and its several details are capable of modifications in various obvious respects, all without departing from the invention. Accordingly, the drawings and description thereof are to be regarded as illustrative in nature, and not as restrictive.

Brief Description of the Drawings

The present invention is illustrated by way of example, and not by limitation, in the figures of the accompanying drawings, wherein elements having the same reference numeral designations represent like elements throughout and wherein:

Figure 1 is a high level block diagram of a computer system usable with the present invention;

Figure 2 is a block diagram of an exemplary network architecture usable with the present invention;

Figure 2A is a schematic illustration of various event stream objects usable in the present invention;

Figure 3 is an illustration of events being ingested by a presence and sorted using rules and actions into streams;

Figure 4 is an illustration of an event explorer window;

Figure 5 is an illustration of a stream rules/criteria window;

Figure 6 is an illustration of a stream actions/matched tasks window;

Figure 7 is an illustration of a stream management/general window;
Figure 8 is an illustration of a stream management/substreams window;
Figure 9 is an illustration of an event search window; and
Figure 10 is an illustration of an event display stream.

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Best Mode for Carrying Out the Invention

A method and apparatus for monitoring of incoming data streams and sorting the incoming data streams into event streams according to the present invention are described. In the following detailed description, for purposes of
10 explanation, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be readily apparent, however, that the present invention may be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form in order to unnecessarily obscure the present invention.

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HARDWARE OVERVIEW

Figure 1 is a block diagram illustrating an exemplary computer system
100 upon which an embodiment of the invention may be implemented. The present invention is usable with currently available personal computers, mini-
20 mainframes and the like. The computer system 100 can be a "presence" as described below.

Computer system 100 includes a bus 102 or other communication
mechanism for communicating information, and a processor 104 coupled with the bus 102 for processing information. Computer system 100 also includes a main
25 memory 106, such as a random access memory (RAM) or other dynamic storage device, coupled to the bus 102 for storing information and instructions to be executed by processor 104. Main memory 106 also may be used for storing temporary variables or other intermediate information during execution of instructions to be executed by processor 104. Computer system 100 further

includes a read only memory (ROM) 108 or other static storage device coupled to the bus 102 for storing static information and instructions for the processor 104. A storage device 110, such as a magnetic disk or optical disk, is provided and coupled to the bus 102 for storing information and instructions.

5 Computer system 100 may be coupled via the bus 102 to a display 112, such as a cathode ray tube (CRT) or a flat panel display, for displaying information to a computer user. An input device 114, including alphanumeric and other keys, is coupled to the bus 102 for communicating information and command selections to the processor 104. Another type of user input device is
10 cursor control 116, such as a mouse, a trackball, or cursor direction keys for communicating direction information and command selections to processor 104 and for controlling cursor movement on the display 112. This input device typically has two degrees of freedom in two axes, a first axis (e.g., x) and a second axis (e.g., y) allowing the device to specify positions in a plane.

15 The invention is related to the use of a computer system 100, such as the illustrated system, to display enterprise architecture information. According to one embodiment of the invention, enterprise architecture information and display is provided by computer system 100 in response to processor 104 executing sequences of instructions contained in main memory 106. Such instructions may
20 be read into main memory 106 from another computer-readable medium, such as storage device 110. However, the computer-readable medium is not limited to devices such as storage device 110. For example, the computer-readable medium may include a floppy disk, a flexible disk, hard disk, magnetic tape, or any other magnetic medium, a CD-ROM, any other optical medium, punch cards, paper
25 tape, any other physical medium with patterns of holes, a RAM, a PROM, an EPROM, a FLASH-EPROM, any other memory chip or cartridge, a carrier wave embodied in an electrical, electromagnetic, infrared, or optical signal, or any other medium from which a computer can read. Execution of the sequences of instructions contained in the main memory 106 causes the processor 104 to

perform the process steps described below. In alternative embodiments, hard-wired circuitry may be used in place of or in combination with computer software instructions to implement the invention. Thus, embodiments of the invention are not limited to any specific combination of hardware circuitry and software.

5 Computer system 100 also includes a communication interface 118 coupled to the bus 102. Communication interface 108 provides a two-way data communication as is known. For example, communication interface 118 may be an integrated services digital network (ISDN) card or a modem to provide a data communication connection to a corresponding type of telephone line. As another
10 example, communication interface 118 may be a local area network (LAN) card to provide a data communication connection to a compatible LAN. In the preferred embodiment communication interface 118 is coupled to a virtual blackboard. Wireless links may also be implemented. In any such implementation, communication interface 118 sends and receives electrical,
15 electromagnetic or optical signals which carry digital data streams representing various types of information. Of particular note, the communications through interface 118 may permit transmission or receipt of the enterprise architecture information. For example, two or more computer systems 100 may be networked together in a conventional manner with each using the communication interface
20 118.

Network link 120 typically provides data communication through one or more networks to other data devices. For example, network link 120 may provide a connection through local network 122 to a host computer 124 or to data equipment operated by an Internet Service Provider (ISP) 126. ISP 126 in turn
25 provides data communication services through the world wide packet data communication services through the world wide packet data communication network now commonly referred to as the "Internet" 128. Local network 122 and Internet 128 both use electrical, electromagnetic or optical signals which carry digital data streams. The signals through the various networks and the signals on

network link 120 and through communication interface 118, which carry the digital data to and from computer system 100, are exemplary forms of carrier waves transporting the information.

Computer system 100 can send messages and receive data, including
 5 program code, through the network(s), network link 120 and communication interface 118. In the Internet example, a server 130 might transmit a requested code for an application program through Internet 128, ISP 126, local network 122 and communication interface 118.

The received code may be executed by processor 104 as it is received,
 10 and/or stored in storage device 110, or other non-volatile storage for later execution. In this manner, computer system 100 may obtain application code in the form of a carrier wave.

Sub B1
 15 As depicted in Figure 2, a network usable with the present invention includes a presence 150, a computer system 160 and a computer system 170 connected to a network such as the Internet. The network illustrated in Figure 2 can also be called a virtual space. Other types of networks such as local area networks, wide area networks and the like can also be used with the present invention. The presence 150 includes the computer software used in the present invention. Other computer systems including the depicted computer systems 172
 20 and 174 generate message traffic which is sent to presence 150. The presence 150 is expecting the event stream sent by the gatherer agent to be of a predetermined format. The presence 150 is configured to be able to use this native format information and, if necessary, perform a transformation. The information sent by a gatherer agent should have information such

Sub B2
 25 Computer system 160 includes an illustrated hunter agent 175 and a message database 180. The hunter agent 175 is sent by the presence 150 to the computer system 160. The message database 180 can receive information from many sources such as the illustrated satellite link. Functionally, an agent is computer software, transportable over a computer network from one computer to

another, to implement a desired function on the destination computer. An agent can also be defined as a transferable self-contained set of executable code instructions. The hunter agent 175 uses information contained in the message database 180 to create and send an event stream object (ESO) 182 to the presence 150. A relationship 184 exists between the ESO 182 and the message database 180. The hunter agent 175 have to go out and look for information contained in databases throughout the network. The hunter agent can transform the events into a standardized format for use by the presence which can include at least some of the following information associated with each event: type, title, datetime, keywords, summary, priority, and duration.

Computer system 170 includes an illustrated gatherer agent 190 and a database 195. The gatherer agent 190 is sent by the presence to the computer system 170. The database 195 can receive information from many sources such as the illustrated satellite link. The gatherer agent 190 sends information to the presence 150. The gatherer agent 190 relays information to the presence in a native format as the information is updated at the database 195. The events will have at least some of the following information associated with each event: type, title, datetime, keywords, summary, priority, and duration.

There are three basic types of event stream object production as used by a cluster of presence entities, as illustrated in Figure 2A.

The first, "Hunter Dynamic" 200, depicts the extraction of event information from a legacy data source. In this case, an event stream object specialized 202 to the particular legacy data type is created to represent the data source record. This specialized object 202 retains a pointer back to the original record, allowing it to extract additional information and update information as appropriate.

The second, "Hunter Static" 204, also depicts the extraction of event information from a legacy data source. In this case, however, a generic event

stream object 206 is created and the standard information elements are "filled in" as appropriate.

Third, the "Gatherer" approach shows the identification of newly created information in "new development" data sources 208. In this case, it is assumed
 5 that the information objects 210 were developed with the standard event stream interface 212 and elements in mind, and can thus be used by the presence with no additional modification.

Finally, the diagram depicts each of the event stream objects being sent to a top-level presence entity 150 for its use, and any delegated use by subordinate
 10 presence objects.

As illustrated in Figure 3, events sent by computer systems 160, 170, 172, 174 to the presence 150. Preferably, the events or event streams sent by the computer systems 160, 170, 172, 174 are in a standardized format and include the information listed above for the hunter 175 and gatherer 190 agents. It may be
 15 necessary to have separate code at the presence 150 for standardizing the incoming message traffic. The presence 150 includes the inventive computer software for applying rules and taking actions of the events ingested by the presence 150 and sorting the ingested events into streams of events 220, 222, 224. Only three streams are depicted although the present invention is not limited to
 20 any specific number of streams. Events received by a presence are usually organized into logical groupings known as streams. These streams can be used to systematize information. The stream names are devised by the user and events are moving onto streams through the automatic application of rules created by the user.

25 With the previous description in mind, before describing the present invention in further detail, some paradigms and definitions are provided. Because of the popularity of "desktop metaphor" user environments such as Apple's Macintosh and Microsoft's Windows, most everyone is familiar with the spatial visualization of hierarchical organizations as "documents" contained within

“folders”. Like file cabinets in the real world, such an organization can be effective if the user has a limited quantity of fairly static information.

As the information the user handles becomes increasingly “active”, the user must spend a greater amount of his or her time managing the organization –
 5 removing outdated information, filing freshly received reports and organizing new assignments.

The present invention replaces the static spatial metaphor with one based on a dynamic temporal flow. In the present invention, information is presented as events spread over a timeline with a past, present and future. This organization
 10 provides the user with an “as it happens” record of the things that occur, tasks assigned to the user and actions taken by the user.

Event and streams are manipulated with a set of commands that make it easy to organize, analyze, and exploit the information that makes up the virtual world of the user. The building blocks of the present invention – Presence, Event
 15 and Stream are discussed below.

Event

An event represents something that happened in the “real” world. The event can be a value received from a sensor, results from an expert system
 20 analysis, a work assignment from a supervisor or a request from a co-worker that the user approve a decision.

An event is composed of a number of standardized elements; it also allows for an infinite variety of extensions specific to the “something” that it represents. An example of an event summary is illustrated in Figure 4 as the event summary
 25 display. The following are standardized elements of an event:

- Type – the type of event.
- Title – the “name” of the event.
- Datetime – an event “happens” at a particular date and time.
- Keywords – a list of words that describe the event.

- Summary – a brief overview of the information in the event.
- Priority – the importance of an event; there are five levels described.

- Duration – the length of time that an event occurred (optional).

5 An event also has a standardized set of operations that can be performed on it. These are:

- Copy – add a reference to the event to some other presence.
- Move – move the current event reference to some other presence.
- Delete – remove the current event reference.

10 • Display – display the full information represented by the event.

In addition to these operations, event types can define custom operations that can be performed on a given event. In the case of an event representing the arrival of a mail message, possible extended options could be to “Reply” or “Forward” it. An event representing the “crash” of a computer system could offer the user extended options related to dealing with it, such as “Attempt Restart” or “Submit Service Order”. Events representing occurrences with a geo-spatial dimension, such as power outage reports, could offer the user extended options relating to charting their location on a map.

20 **Presence**

A presence represents an individually identifiable entity within the virtual space. The user is a presence, as are co-workers. Organizational departments such as maintenance or publications could also be represented by a presence. Although only one presence is depicted in Figure 2, there can be many presences in the virtual space.

A presence is the basic unit for external interaction or collaboration within the virtual space. The user receives information and assignments from other presence entities. Should the user want to send information or a request elsewhere, the user targets a presence to receive the information.

A presence is working all the time, whether the user is logged on to a computer or not. The presence is always available to receive and act on incoming events. When an event is received by the presence, it follows instructions that help the presence to determine what, if anything, to do with the event. These instructions are called rules and are made from two components: criteria and actions.

Criteria are simple statements that examine the values of the standardized data elements in the event. An example of a criteria statement might be "Type is equal to Lightning Strike". A rule can have many individual criteria statements, and a rule can require that either all, any, or none of the individual criteria statements be satisfied. Examples of stream rules are depicted in Figure 5.

Using a rule, after the processor 104 in presence 150 has determined that the criteria have been met for a particular event, actions can then be performed. Actions are commands that the presence 150 can perform to help filter, organize, and exploit information sent by the hunter agent 175, gatherer agent 190 and other incoming message traffic from computer systems 172, 174. Organizational actions let the user file incoming information in the user's personal organizational scheme. For example, streams 220, 222, 224 in Figure 3 can be stored in separate files. As illustrated in Figure 4, there are five separate files associated with five sorted streams: zone 1 issues, zone 2 issues, zone 3 issues, resource requests and local resource schedules. Other actions allow the user to have the information automatically brought to the user's attention with various notification mechanisms such as alert windows, flashing icons, email or beeper notification as depicted in Figure 6.

The user interacts with the computer software of the present invention through a graphical user interface (GUI) application. The GUI is a tool for organizing and browsing information sent to the user's "presence".

When the user first launches the computer software of the present invention, a window like the one illustrated in Figure 4 will appear. This window

has seven areas: Toolbar, Summary Panel, Event Size Controls, Timeline Scaling Controls, Time Progression Mode Control, Highlight Time Display and the EventStream Display.

Selecting the “setup” menu in Figure 4 offers the user three choices:
 5 Stream Rules (Figures 5 and 6), Stream Management (Figures 7 and 8) and Preferences. The first two choices “Stream Rules” and “Stream Management” are discussed below.

The Preferences choice brings up a window allowing the user to configure, for example, ease-of-use (e.g., keyboard shortcuts) and cosmetic (e.g., window
 10 color) features.

Stream Rules

Selecting “stream Rules” brings up a window like the one shown in Figure
 5. The window illustrated in Figure 5 allows the user to create rules which check
 15 each event received in the data stream against criteria. If all criteria are matched then matched actions (Figure 6) are performed; likewise a failure to match all criteria can cause unmatched actions to be performed. The criteria are formed by simple pattern matching statements allowing the user to compare the contents of fields in each event with values selected by the user. These statements allow the
 20 user to, for example, check the type of event, time it occurred, and the contents of the event’s keyword list.

The actions that can be performed in the “Matched” or “Unmatched” cases include placing an event on one or more streams, informing the user via alert or sound, or deleting the event. Other operations appropriate to your environment
 25 may be available as well.

Selecting “Streams Management” from the “Setup” menu will open the window illustrated in Figure 7 to appear. In this window, the user can set preferences for each stream. With a stream selected in the leftmost list, the user can set general preferences for the stream and create, edit or modify display

substreams (Figure 8) for the stream. Display substreams are simply a means available to “declutter” a display of events within a stream.

Toolbar

- 5 The toolbar offers five commands. The five commands are:
- Back – Shift stream display to show older events.
 - Go To – Shift stream display to center a particular time on the display.
 - Forward – Shift stream display to show more recent events.
 - 10 Search – Search the stream for events matching some criteria.
 - New – Create a new event and place it on a stream.

Pressing “Go To” pops up a menu where the user can either center the current time on the display (the default action), or enter a datetime to center the display on.

- 15 Pressing “New” pops up a menu where the user can select a type of event to be created. Once the user makes a selection, the event will be created, and a window will be created to specify the event information. The event types available and the interface used to specify them will vary from system to system.

20 Search

- Pressing “Search” brings up a window like the one illustrated in Figure 9. Within this window, search criteria can be entered to locate a particular event. Pressing “Find” will cause the computer software to focus on the desired event. If more than one matching event is found, repeatedly selecting “Find” will bring
- 25 each up in succession.

Event Summary Display

The output of the sorted, selected and displayed event streams is depicted in the Event Stream Display in Figure 10. The top part of the display is the

Stream Selection area and allows the user to select a stream to be displayed. There can only be one stream selected. If the user has more streams than can be displayed in the Stream Selection area, the Stream Title Navigation Controls will be active, allowing the user to move within a list of stream titles.

- 5 The titles displayed in the Stream Selection area may present cues to any unacknowledged priority events within the stream. The color coding (black, yellow and red) indicates increasing levels of significance. If the title itself is yellow or red, it means that there is a priority event within the "current time" window. The size of this window is configurable via the "Streams Management" window in illustrated in Figure 7. Similarly, colored markers before or after the title text indicates the presence of unacknowledged priority events before or after the current time window.

- 10 Immediately below the Steam Selection area is where events are displayed. A stream can have several substreams, and the display in Figure 10 illustrates a stream with two substreams.

- 15 The Current Time Indicator shows the user where the current time is centered on the display. The default location for this indicator (useful when using the "Now" toolbar command) can be moved from side to side by using the small square handles at the ends of the indicator.

- 20 It will be readily seen by one of ordinary skill in the art that the present invention fulfills all of the objects set forth above. After reading the foregoing specification, one of ordinary skill will be able to affect various changes, substitutions of equivalents and various other aspects of the invention as broadly disclosed herein. It is therefore intended that the protection granted hereon be limited only by the definition contained in the appended claims and equivalents thereof.
- 25